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(54) SUBSTRATE SUPPORT FOR SUBSTRATE BACKSIDE CONTAMINATION CONTROL

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H05B 3/14 (2006.01)
H01L 21/687 (2006.01)

(52) **U.S. Cl.**
CPC ... ***H01L 21/67109*** (2013.01); ***H01L 21/67103*** (2013.01); ***H01L 21/6875*** (2013.01); ***H05B 3/143*** (2013.01)

(58) **Field of Classification Search**
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USPC 118/724, 725; 219/121.58
See application file for complete search history.

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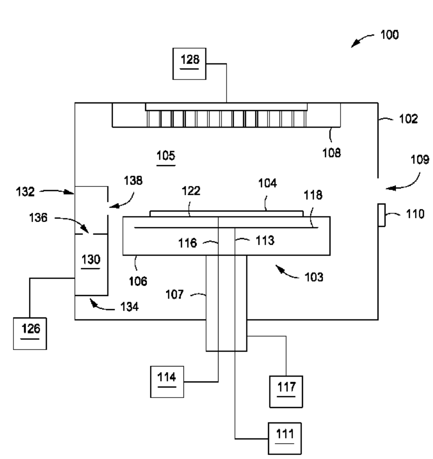
(57) **ABSTRACT**

Embodiments of substrate supports are provided herein. In some embodiments, a substrate support may include a first aluminum plate for supporting a substrate, the first aluminum plate having a plurality of heating elements embedded therein to provide a plurality of heating zones; a second aluminum plate disposed beneath and supporting the first aluminum plate; a third aluminum plate disposed beneath and supporting the second aluminum plate; a non-metallic ring disposed atop the first aluminum plate; and a plurality of spacers having an upper portion disposed above a surface of the first aluminum plate, wherein the non-metallic ring and the plurality of spacers support the substrate above the first aluminum plate.

18 Claims, 5 Drawing Sheets



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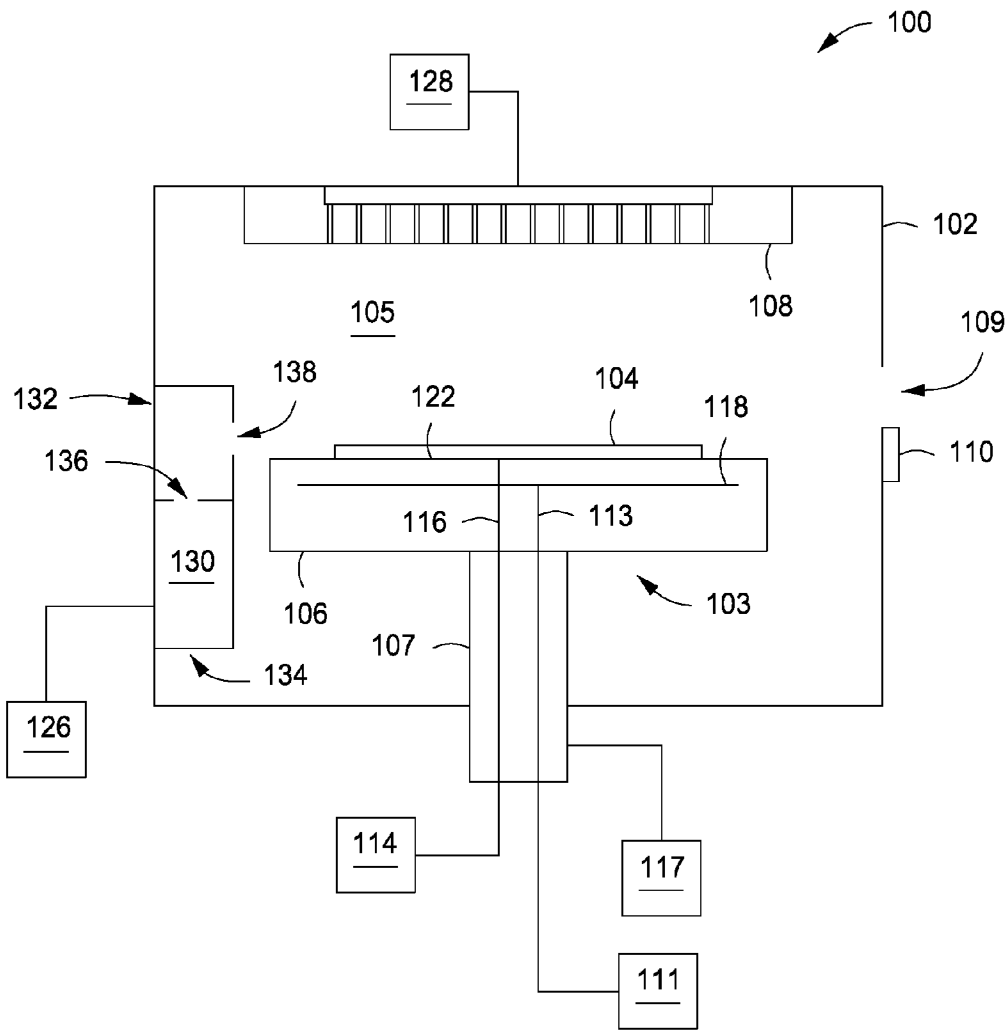
100
128
102
108
105
109
138
104
132
122
118
110
136
116
113
130
103
106
107
134
126
114
117
111

FIG. 1

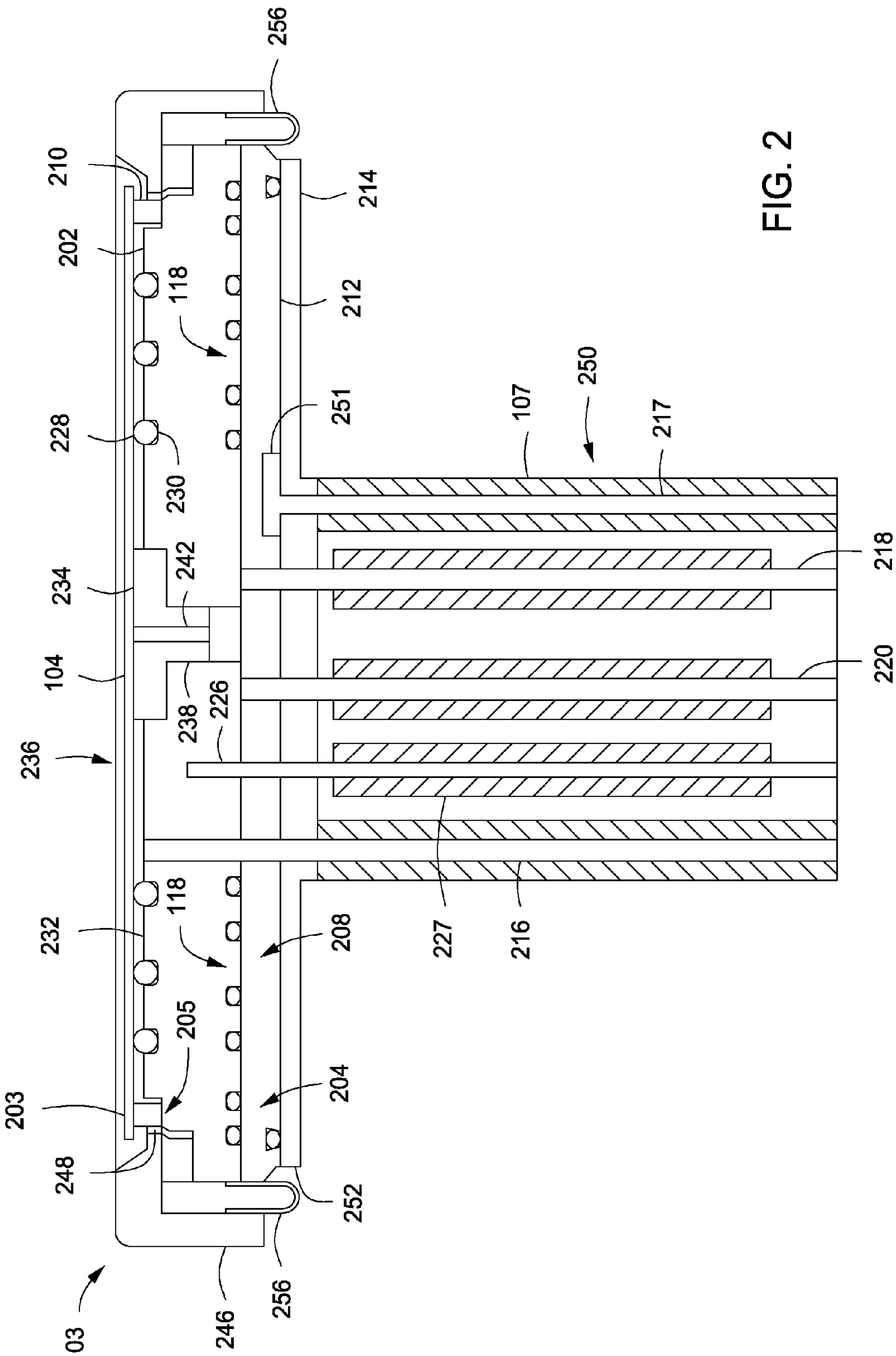
256
210
214
202
118
212
250
107
251
217
228
230
234
242
218
104
220
238
226
236
232
118
208
227
216
205
204
203
248
252
256
246
103

FIG. 2

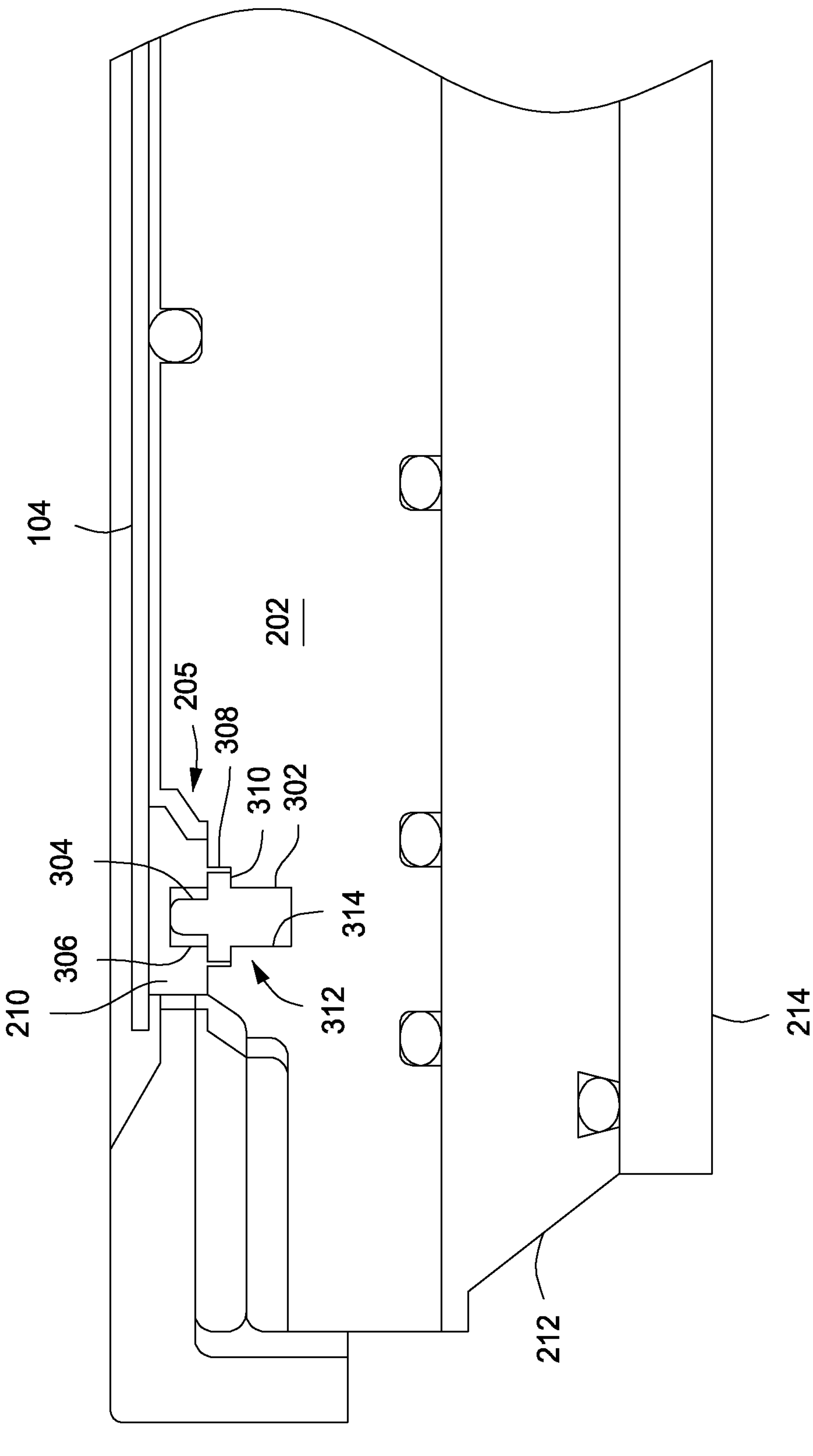

FIG. 3

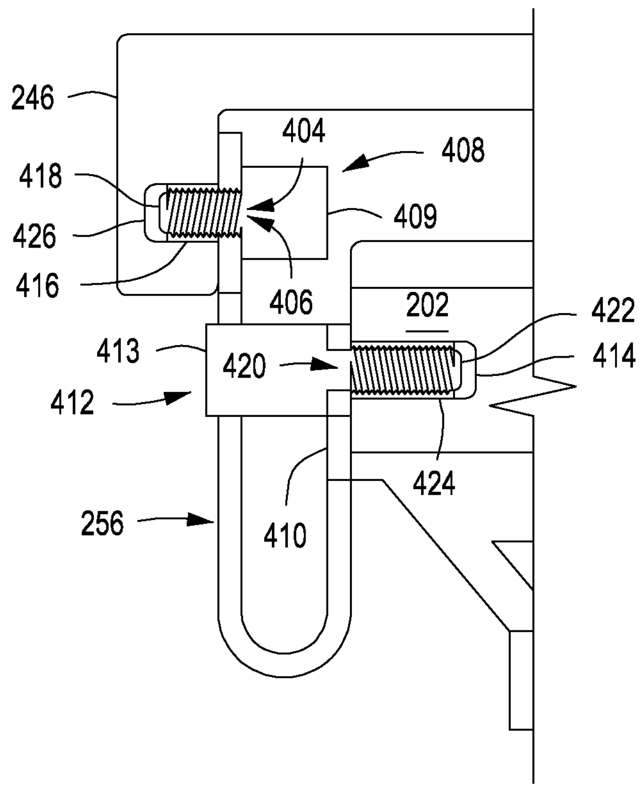
246
404
408
418
409
426
416
406
202
422
414
413
420
412
424
410
256

FIG. 4

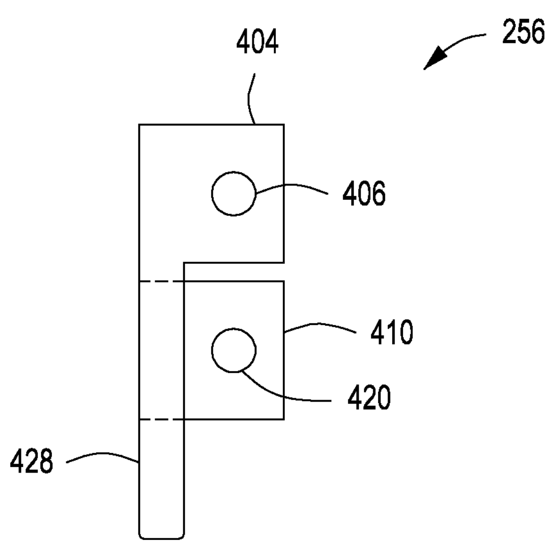
256
404
406
410
420
428

FIG. 5

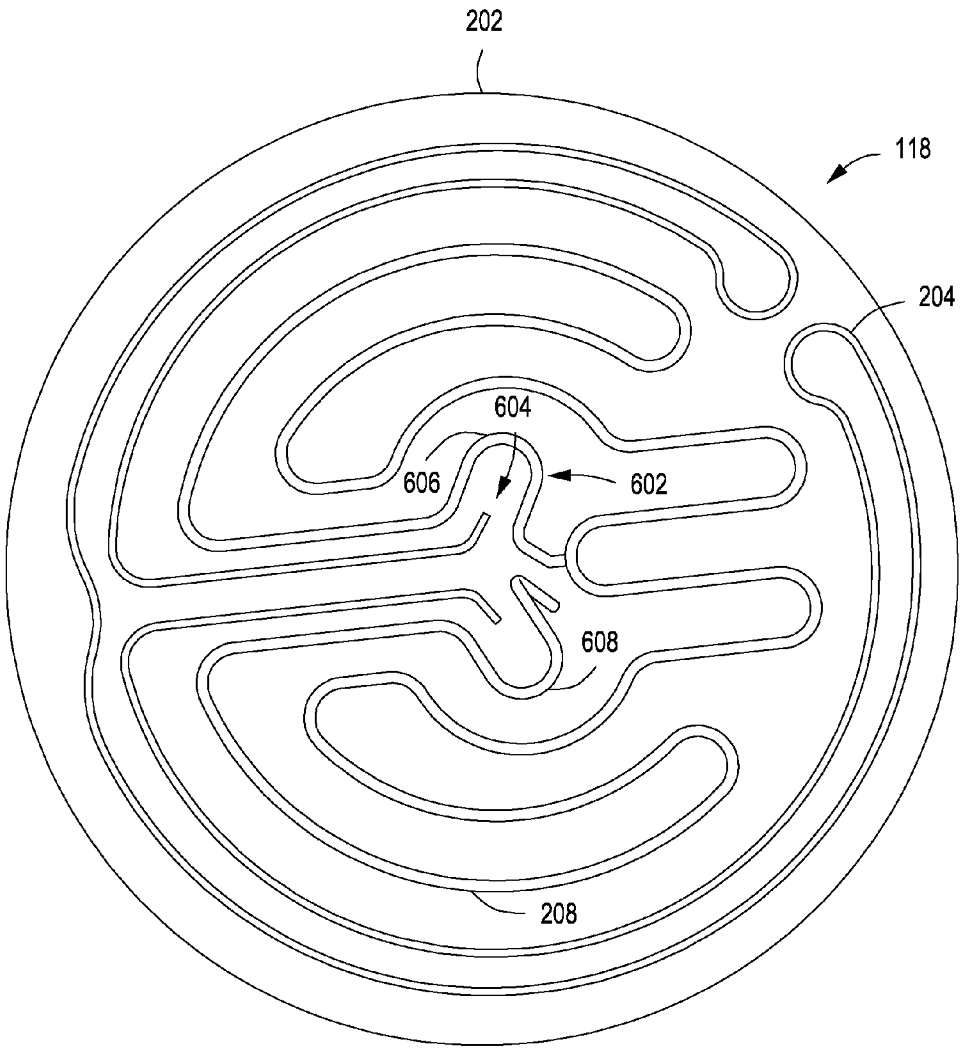

FIG. 6

SUBSTRATE SUPPORT FOR SUBSTRATE BACKSIDE CONTAMINATION CONTROL

FIELD

Embodiments of the present invention generally relate to a semiconductor processing equipment.

BACKGROUND

Conventional substrate supports utilized in deposition process chambers may include a heater plate fabricated from a steel alloy, for example, such as stainless steel. However, the inventors have observed that the low heat conductivity of stainless steel may create a temperature gradient across the heating plate (e.g., a temperature variation from the center to edge of the heater plate), causing uneven heating of the substrate, thereby leading to process non-uniformities. In addition, the high (radio frequency) RF resistivity of the stainless steel causes non-uniform plasma distribution, thereby further leading to non-uniform deposition of materials atop the substrate in plasma-assisted substrate processes.

The inventors have also observed that when using a substrate support having a metal heater plate during a substrate process (e.g., a deposition process), contamination of the substrate may occur as a result of metal to substrate contact. For example, when utilizing a conventional heater plate fabricated from stainless steel, iron (Fe) from the heater plate may diffuse into a back surface of the substrate, thereby contaminating the substrate.

Therefore, the inventors have provided embodiments of improved substrate supports.

SUMMARY

Embodiments of substrate supports are provided herein. In some embodiments, a substrate support may include a first aluminum plate for supporting a substrate, the first aluminum plate having a plurality of heating elements embedded therein to provide a plurality of heating zones; a second aluminum plate disposed beneath and supporting the first aluminum plate; a third aluminum plate disposed beneath and supporting the second aluminum plate; a non-metallic ring disposed atop the first aluminum plate; and a plurality of spacers having an upper portion disposed above a surface of the first aluminum plate, wherein the non-metallic ring and the plurality of spacers support the substrate above the first aluminum plate.

Other and further embodiments of the present invention are described below.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention, briefly summarized above and discussed in greater detail below, can be understood by reference to the illustrative embodiments of the invention depicted in the appended drawings. It is to be noted, however, that the appended drawings illustrate only typical embodiments of this invention and are therefore not to be considered limiting of its scope, for the invention may admit to other equally effective embodiments.

FIG. **1** depicts a process chamber suitable for use with a substrate support in accordance with some embodiments of the present invention.

FIG. **2** depicts a substrate support in accordance with some embodiments of the present invention.

FIGS. **3**-**5** depict portions of the substrate support of FIG. **2** in accordance with some embodiments of the present invention.

FIG. **6** depicts a heater element configuration suitable for use with a substrate support in accordance with some embodiments of the present invention.

To facilitate understanding, identical reference numerals have been used, where possible, to designate identical elements that are common to the figures. The figures are not drawn to scale and may be simplified for clarity. It is contemplated that elements and features of one embodiment may be beneficially incorporated in other embodiments without further recitation.

DETAILED DESCRIPTION

Substrate supports that may provide one or more of improved backside contamination control, heat distribution, or improved plasma uniformity are provided herein. Embodiments of the inventive substrate support may advantageously support a substrate above a heater plate during processing, thereby eliminating any direct substrate to metal contact, thus reducing or eliminating contamination of the substrate. Embodiments of the inventive substrate support may further advantageously provide a heater plate fabricated from aluminum, thereby providing an improved heat distribution over conventionally utilized stainless steel heater plates, due to the higher heat conductivity of aluminum as compared to stainless steel. In addition, the lower RF resistivity of aluminum (as compared to stainless steel), facilitates providing an improved RF grounding path, thereby providing improved plasma uniformity in plasma-assisted processes. While not intended to be limiting of the scope of the invention, the inventive substrate support disclosed herein may be particularly advantageous in process chambers configured for chemical vapor deposition (CVD) having radio frequency (RF) capability, for example such as CVD process chambers suitable to process 200, 300, or 450 mm substrates, or the like.

FIG. **1** depicts a process chamber **100** suitable for use with a substrate support having a heater in accordance with some embodiments of the present invention. The process chamber **100** may be any process chamber suitable for performing one or more substrate processes, for example, deposition process such as chemical vapor deposition (CVD), physical vapor deposition (PVD), atomic layer deposition (ALD) or the like. In embodiments where the process chamber is a CVD chamber, the CVD chamber may be any suitable CVD chamber known in the art. For example, the CVD chamber may be a standalone process chamber or a part of a cluster tool, such as one of the CENTURA®, PRODUCER®, or ENDURA® cluster tools available from Applied Materials, Inc. of Santa Clara, Calif.

In some embodiments, the process chamber **100** may generally include a chamber body **102**, a substrate support **103** for supporting a substrate **104** and one or more gas inlets (e.g., showerhead **108**) for providing one or more processes gases to an inner volume **105** of the chamber body **102**.

In some embodiments, the chamber body **102** may comprise one or more openings (one opening **109** shown) to allow for the substrate **104** to be provided to, and removed from, the process chamber **100**. The opening **109** may be selectively sealed via a slit valve **110**, or other mechanism for selectively providing access to the inner volume **105** of the chamber body **102** through the opening **109**. In some embodiments, the substrate support **103** may be coupled to a lift mechanism **117** that may control the position of the substrate support **103** between a lower position (as shown) suitable for transferring substrates into and out of the chamber via the opening **109** and a selectable upper position suitable for processing. The process position may be selected to maximize process uniformity for a particular process. When in at least one of the elevated processing positions, the substrate support **103** may be disposed above the opening **109** to provide a symmetrical processing region.

The one or more gas inlets (e.g., showerhead **108**) may be coupled to a first gas source **128** for providing one or more process gases for carrying out processes in the process chamber **100**. Although a showerhead **108** is shown, additional or alternative gas inlets may be provided such as nozzles or inlets disposed in the ceiling or on the sidewalls of the process chamber **100** or at other locations suitable for providing gases as desired to the process chamber **100**, such as the base of the chamber body **102**, the periphery of the substrate support **103**, or the like.

In some embodiments, the process chamber **100** further includes an exhaust **130** coupled to a pump **126** for removing process gases, purge gases, processing byproducts, and the like from the process chamber **100**, for example, via one or more openings **138** fluidly coupling the inner volume **105** of the chamber body **102** with the exhaust **130**. In some embodiments, the exhaust **130** may be disposed about the walls of the chamber body **102** and may further be split into an upper exhaust **132** and a lower exhaust **134** with one or more openings **136** disposed between the upper and lower exhaust **132**, **134** to control the flow of the process gases, etc., through the exhaust **130** and to the pump **126** (e.g., to provide more azimuthally uniform flow from the processing region of the process chamber above the substrate to the exhaust **130** due to the asymmetric pump configuration).

The substrate support **103** generally comprises a plate (heater plate) **106** configured to support the substrate **104** and a substrate support shaft **107** to support the plate **106**. In some embodiments, one or more heating elements **118** may be embedded within or recessed within the plate **106**, thereby allowing the plate **106** to function as a heater. A power source may provide power to the heating element **118** via a conduit **113** disposed within the substrate support shaft **107**. In some embodiments, a sheath may be provided to surround heating elements **118**. The sheath may be fabricated from a conductive metal, for example, such as aluminum. The inventors have observed that fabricating sheaths of the heating elements **118** from aluminum may provide an improved heat distribution over conventionally utilized stainless steel sheathed heater elements due to the high heat conductivity of aluminum as compared to stainless steel. In addition, the aluminum sheaths have the same thermal expansion as the heater plate **106**, thereby reducing or eliminating thermal stresses that may occur due to thermal expansion/contraction mismatch between components.

In some embodiments, a gas, for example a purge gas (e.g., an inert gas, such as argon), may be provided by a second gas source **114** to a backside **122** of the substrate **104** via a conduit **116**. One or more second conduits (not shown) may be provided to deliver the purge gas proximate the edge of the substrate **104**.

The inventors have observed that conventional substrate supports utilized in deposition process chambers typically include a heater plate (e.g., plate **106**) fabricated from a steel alloy, for example, such as stainless steel. However, the inventors have observed that the low heat conductivity of stainless steel creates a temperature gradient across the heating plate (e.g., a temperature range from the center to edge of the heater plate), causing uneven heating of the substrate, thereby leading to process non-uniformities. In addition, the high (radio frequency) RF resistivity of the stainless steel causes non-uniform plasma distribution, thereby further leading to non-uniform deposition of materials atop the substrate.

Accordingly, in some embodiments, the heater plate **106** may be fabricated from aluminum (Al). The inventors have discovered that a heater plate fabricated from aluminum may provide an improved heat distribution over conventionally utilized stainless steel heater plates due to the high heat conductivity of aluminum as compared to stainless steel. In addition, because of the lower RF resistivity of aluminum (as compared to stainless steel), an improved RF grounding path may be provided, thereby providing an improved plasma uniformity.

Details of the substrate support **103** in accordance with at least some embodiments of the invention are further described in FIG. **2**, which depicts a more detailed view of the substrate support **103** of FIG. **1**. In FIG. **2**, an embodiment of the heater plate **106** is shown as heater plate **202** (e.g., a first plate). In some embodiments, the heating elements **118** may be embedded or recessed within the heater plate **202**, such as shown in FIG. **2**. In some embodiments, the heating elements **118** may be configured such that multiple heating zones (e.g., outer heating zone **204** and inner heating zone **208** as shown) are present across the heater plate **202**. Greater or fewer zones may also be provided.

In some embodiments, the substrate support **103** may comprise one or more additional plates (such as second plate **212** and third plate **214** shown in FIG. **2**) disposed beneath the heater plate **202** (e.g., the first plate). In such embodiments, the additional plates (e.g., **212**, **214**) may be fabricated from aluminum. By fabricating all of the substrate support plates (i.e., the heater plate **202**, second plate **212** and third plate **214**) from aluminum, the inventors have observed that a heat transfer from the heating elements may be faster and more uniform, as compared to conventional substrate support plates fabricated from, for example, stainless steel. The substrate support plates may be coupled together via any process suitable to couple aluminum, for example, such as welding, brazing or the like.

The inventors have observed that when using a substrate support having a metal heater plate (e.g., substrate support **103** and heater plate **202**) during a substrate process (e.g., a deposition process), contamination of the substrate may occur as a result of metal to substrate contact. For example, when utilizing a conventional heater plate fabricated from stainless steel, iron (Fe) from the heater plate may diffuse into a back surface of the substrate, thereby contaminating the substrate. Accordingly, in some embodiments, a plurality of non-metallic spacers **228** may be disposed between the substrate **104** and the heater plate **202**. The inventors have observed that by providing the plurality of non-metallic spacers **228**, the substrate **104** is supported above the heater plate **202** during processing, thereby eliminating any direct substrate **104** to metal contact, thus reducing or eliminating contamination of the substrate **104**. In addition, the inventors have observed that by supporting the substrate **104** above the heater the gap **232** formed between the substrate **104** and the heater plate **202** provides an improved substrate backside pressure control that reduces vacuum pressure drop at the substrate edge, thereby retaining a desired clamping force on the substrate.

The non-metallic spacers **228** may be fabricated from any non-metallic material suitable to support the substrate **104** above the heater plate **202** while being resistant to the environment within the process chamber during processing. For example, in some embodiments, the non-metallic spacers **228** may be fabricated from a crystalline form of aluminum oxide (Al_2O_3) (e.g., sapphire), aluminum nitride (AlN), or the like. The non-metallic spacers **228** may have any shape suitable to support the substrate **104**. For example, in some embodiments, each non-metallic spacer **228** may be substantially spherical and may be held in place in corresponding recesses formed in an upper surface of the heater plate **202**. The size of the non-metallic spacers **228** may selected to provide the gap **232** with a size sufficient to prevent contamination of the substrate **104** from material of the heater plate **202**. For example, in some embodiments, the gap **232** may be about 0.002 to about 0.010 inches, or in some embodiments, about 0.007 inches.

The non-metallic spacers **228** may be disposed between the substrate **104** and heater plate **202** in any manner suitable to support the substrate **104** in a static position during processing. For example, in some embodiments, the non-metallic spacers **228** may be partially recessed into openings **230** formed in the heater plate **202**. In such embodiments, the non-metallic spacers **228** maybe secured in place via any means suitable, for example, such as a swaging process (e.g., via a swage press).

In addition to the non-metallic spacers **228**, in some embodiments, a non-metallic seal ring **210** may be disposed atop the heater plate **202** to further support the substrate **104** above the heater plate **202** and to provide a seal between the processing volume within the process chamber and the region between the substrate and the heater plate (e.g., the gap **232**). When present, the non-metallic seal ring **210** supports the substrate **104** proximate a peripheral edge **203** of the substrate. The non-metallic seal ring **210** may be fabricated from any non-metallic material suitable to support the substrate **104** above the heater plate **202** while being resistant to the processing environment. For example, in some embodiments, the non-metallic seal ring **210** may be fabricated from aluminum nitride (AlN), aluminum oxide (Al_2O_3) or the like.

The non-metallic seal ring **210** may have any thickness suitable to support the substrate **104** such that a desired gap (e.g., the gap **232** discussed above) is formed between the substrate **104** and heater plate **202**. However, the inventors have observed that as the thickness of the non-metallic seal ring **210** increases, the non-metallic seal ring **210** may be susceptible to breakage due to thermal stresses. Moreover, as the thickness of the non-metallic seal ring **210** increases, an impedance difference between a center of the substrate **104** and an edge of the substrate **104** during processing may increase, leading to process non-uniformities. Accordingly, in some embodiments, the non-metallic seal ring **210** may be about 0.10 to about 0.30 inches thick. The non-metallic seal ring **210** may be positioned atop the heater plate **202** in any manner suitable to support the substrate **104** above the heater plate **202**. For example, in some embodiments, the non-metallic seal ring **210** may be disposed directly atop a top surface of a peripheral edge of the heater plate **202**. In some embodiments, the non-metallic seal ring **210** may sit on a recess or cutout **205** of the heater plate **202**, such as shown in FIG. **2**.

In some embodiments, one or more pins may be utilized to center the non-metallic seal ring **210** with respect to the heater plate **202**. For example, FIG. **3** depicts a pin **312** extending from the heater plate **202** to center the non-metallic seal ring **210** with respect to the heater plate **202**. The one or more pins **312** may comprise any electrically insulating material, such a ceramic, for example, aluminum oxide (Al_2O_3), aluminum nitride (AlN), or the like. In some embodiments, each of the one or more pins **312** may comprise a top portion **304** configured to interface with a feature **306** formed in the non-metallic seal ring **210** and a bottom portion **314** configured to interface with a recess **302** formed in the heater plate **202**. In some embodiments, each of the each of the one or more pins **312** may comprise a flange **308** configured to interface with a top portion **310** of the recess **302**. In some embodiments, three pins **312** may be provided in an azimuthally symmetric arrangement.

Referring back to FIG. **2**, in addition to the non-metallic spacers **228**, in some embodiments, a non-metallic disk **234** may be disposed proximate a center **236** of the heater plate **202** to further support the substrate **104** above the heater plate **202**. The non-metallic disk **234** may comprise any electrically insulating material, such a ceramic, for example, aluminum oxide (Al_2O_3), aluminum nitride (AlN), or the like. In some embodiments, the non-metallic disk **234** may be at least partially recessed into an opening formed in the heater plate **202**.

In some embodiments, the non-metallic disk **234** may include a shaft **238** coupled to and extending outwardly from a bottom portion of the non-metallic disk **234** and through a corresponding opening in the heater plate **202**. In such embodiments, the shaft **238** and non-metallic disk **234** may include a through hole **242** to prevent gas from being trapped between the non-metallic disk **234** and the heater plate **202**. The shaft **238** may be fabricated from a different, or in some embodiments, the same material used to fabricate the non-metallic disk **234**. In some embodiments, the shaft **238** and non-metallic disk **234** may be fabricated from a single piece of material, thereby providing a single unitary part comprising the shaft **238** and non-metallic disk **234**.

In some embodiments, the substrate support shaft **107** may generally comprise a body **250** having one or more conduits (two conduits **216**, **217** shown) formed therein. The body **250** may be fabricated from any material suitable to support the substrate support **103**, for example, a metal, such as aluminum, or the like.

By utilizing conduits **216**, **217** formed in the body **250** of the substrate support shaft **107**, the inventors have discovered that the conduits **216**, **217** are less susceptible to degradation or failure as compared to conventional substrate support shafts that utilized separate components to form conduits. In some embodiments, the conduits **216**, **217** may be configured to provide gases (e.g., purge gases), a vacuum, or the like, to the heater plate **202**. For example, in some embodiments a first conduit (e.g., conduit **217**) may provide one or more gases to a purge channel **248** via a series of channels **251**, **252** formed in the third plate **214**. In some embodiments, a second conduit (e.g., conduit **216**) may be coupled to a vacuum (not shown) to facilitate chucking the substrate **104** to the substrate support **103**.

In some embodiments, one or more power supply lines (two power supply lines **220**, **218** shown) may be disposed within the substrate support shaft **107** to provide power from a power supply (e.g., power source **111** described above) to the heating elements **118**. In addition, in some embodiments, a thermocouple probe **226** may be disposed within the substrate support shaft **107** and extending into a portion of the heater plate **202** to facilitate monitoring a temperature of the heater plate **202**. In some embodiments, at least a portion of the thermocouple probe **226** and/or the power supply lines **220**, **218** may be enclosed within an aluminum tube (aluminum tube **227** shown for thermocouple probe **226**). In some embodiments, the aluminum tube **227** may be coupled to the substrate support shaft **107** via any process suitable to provide a secure coupling, for example, via welding, brazing or the like. By enclosing the thermocouple probe within the aluminum tube **227**, the inventors have observed that a noise coupling from the power supply lines **220**, **218** and the thermocouple probe **226** may be reduced or eliminated, thereby facilitating a more accurate reading from the thermocouple probe **226**.

In some embodiments, a purge ring **246** may be disposed on the heater plate **202** to define the purge channel **248** to provide a purge gas to a peripheral portion of the substrate **104** to prevent deposition thereon. In some embodiments, the purge ring **246** may be fabricated from a metal, such as aluminum (Al), stainless steel, or the like, or a non-metal material, such a aluminum oxide (Al_2O_3), aluminum nitride (AlN), or the like.

In such embodiments, the inventors have observed that conventionally utilized mechanisms (e.g., via multiple springs and/or metal skirting) to provide a grounding path for a purge ring (e.g., purge ring **246**) fail to provide reliable grounding. Accordingly, in some embodiments, the purge ring **246** and the heater plate **202** may be coupled to one another via a plurality of metal clips (two metal clips **256** shown). The inventors have discovered that utilizing the metal clips **256** to couple each of the purge ring **246** and heater plate **202** provides a more secure and reliable coupling, and therefore a better grounding, as compared to, for example, a spring force contact typically used in conventional substrate supports. The inventors have further discovered that the improved coupling and grounding allows the heater (e.g., heating elements **118** and the heater plate **202** described above) to be reliably operated at broad range of RF frequencies for plasma processes, for example, such as 13.56 MHz, 40 Mhz, or higher.

Referring to FIG. **4**, in some embodiments, each of the plurality of metal clips **256** may comprise a first end **404**, a second end **410** and a u-shaped portion **428** disposed between and coupling the first end **404** to the second end **410**. Each of the first end **404** and second end **410** include a through hole **406**, **420** configured to accommodate a fastener **408**, **412**. In some embodiments, the first end **404** and second end **410** may extend outwardly from the u-shaped portion and may be offset from one another, such as shown in FIG. **5**. Configuring the first end **404** and second end **410** in such a manner allows for clear access to each through hole **406**, **420**, thereby allowing for a simple installation.

Referring back to FIG. **4**, the fastener **408**, **412** can be any type of fastener suitable to couple the metal clips **256** to the purge ring **246** and heater plate **202** while providing an adequate connection to facilitate an electrical grounding of the purge ring **246**. For example, the fastener **408**, **412** may be a rivet, screw, bolt, or the like. In embodiments where the fastener **408**, **412** is a bolt, for example such as shown in FIG. **4**, the fastener **408**, **412** may comprise a head **409**, **413** configured to interface with a tool to allow tightening of the fastener **408**, **412** and a threaded portion **418**, **422** configured to interface with a hole **414**, **426** disposed the purge ring **246** and heater plate **202**. In some embodiments, the hole **414**, **426** may comprise internal threads configured to mate with the threaded portion **418**, **422** of the fastener **408**, **412**. Alternatively, an insert **416**, **424** may be press fit within the hole **414**, **426**.

Referring to FIG. **6**, the heating elements **118** may be configured in any manner to provide a suitable temperature provide to the heater plate **202** for a particular process being performed. For example, in some embodiments, each of the outer heating zone **204** and inner heating zone **208** heating elements **118** may be configured in a recursive pattern, for example, as shown in FIG. **6**. In some embodiments, the heating elements **118** for the inner heating zone **208** may comprise a recursive pattern **602** having one or more loops (two loops **606**, **608** shown) disposed proximate a center **604** of the heater plate **202**. By providing the heating elements **118** in such a manner, the inventors have discovered that a temperature proximate the center **604** of the heater plate **202** may increase, thereby providing a temperature profile having an improved uniformity across the heater plate, as compared to conventionally configured heater elements.

Thus, embodiments of substrate supports that may provide one or more of backside contamination control, improved heat distribution, and improved plasma uniformity have been provided herein. The inventive substrate support may advantageously support a substrate above a heater plate during processing, thereby eliminating any direct substrate to metal contact, thus reducing or eliminating contamination of the substrate. The inventive substrate support may further advantageously provide a heater plate fabricated from aluminum, thereby providing an improved heat distribution over conventionally utilized stainless steel heater plates. In addition, the lower RF resistivity of aluminum (as compared to stainless steel) provides an improved RF grounding path, resulting in improved plasma uniformity.

While the foregoing is directed to embodiments of the present invention, other and further embodiments of the invention may be devised without departing from the basic scope thereof.

The invention claimed is:

1. A substrate support, comprising:

a first aluminum plate for supporting a substrate, the first aluminum plate having a plurality of heating elements embedded therein to provide a plurality of heating zones;

a second aluminum plate disposed beneath and supporting the first aluminum plate;

a third aluminum plate disposed beneath and supporting the second aluminum plate;

a non-metallic ring disposed atop the first aluminum plate, wherein the non-metallic ring is fabricated from aluminum nitride (AlN) or aluminum oxide (Al_2O_3);

a plurality of spacers having an upper portion disposed above a surface of the first aluminum plate, wherein the non-metallic ring and the plurality of spacers support the substrate above the first aluminum plate; and

a non-metallic disk disposed proximate a center of the first aluminum plate, the non-metallic disk having an upper portion disposed above a top surface of the first aluminum plate and a shaft coupled to a bottom of the non-metallic disk, wherein the non-metallic disk, non-metallic ring, and the plurality of spacers support the substrate above the first aluminum plate, and wherein the shaft is disposed within a through hole formed in the first aluminum late.

2. The substrate support of claim **1**, wherein the plurality of spacers are at least partially recessed into a top surface of the first aluminum plate.

3. The substrate support of claim **1**, wherein the plurality of spacers have a substantially spherical shape.

4. The substrate support of claim **1**, wherein the non-metallic ring and the plurality of spacers support the substrate about 0.002 to about 0.010 inches above the first aluminum plate.

5. The substrate support of claim **1**, wherein the plurality of spacers are fabricated from sapphire.

6. The substrate support of claim **1**, wherein the first aluminum plate further comprises a plurality of channels formed in a bottom surface of the first aluminum plate, wherein the heating elements are disposed within the plurality of channels, and wherein the heating elements are secured in the plurality of channels by the second aluminum plate.

7. The substrate support of claim **1**, further comprising:

a plurality of pins, each having a first end disposed in a feature of the first aluminum plate and a second end extending beyond a top surface of the first aluminum plate and configured to interface with a feature formed in a bottom surface of the non-metallic ring to maintain the non-metallic ring in a desired position.

8. The substrate support of claim **1**, wherein the non-metallic disk is at least partially recessed into the first aluminum plate.

9. The substrate support of claim **1**, wherein the non-metallic disk is fabricated from aluminum nitride (AlN) or aluminum oxide (Al_2O_3).

10. The substrate support of claim **1**, wherein the plurality of heating elements comprise:

a first heater element configured to provide heat to an inner portion of the first aluminum plate; and

a second heater element configured to provide heat to an outer portion of the first aluminum plate.

11. The substrate support of claim **10**, wherein a portion of the first heater element comprises two or more curved sections disposed proximate a center of the first aluminum plate to provide heat to an area proximate the center of the first aluminum plate.

12. The substrate support of claim **1**, further comprising a support shaft disposed beneath the third aluminum plate to support the third aluminum plate, the support shaft comprising:

a body having a hollow portion formed within the body; and

one or more conduits formed in the body, wherein each of the one or more conduits are configured to provide a gas or apply a vacuum to an area above the first aluminum plate.

13. The substrate support of claim **12**, wherein the support shaft further comprises:

a thermocouple to provide a temperature of the first aluminum plate, the thermocouple disposed within the hollow portion of the support shaft; and

an aluminum tube surrounding the thermocouple.

14. The substrate support of claim **12**, wherein the support shaft is fabricated from aluminum.

15. A substrate support, comprising:

a first aluminum plate for supporting a substrate, the first aluminum plate having a plurality of heating elements embedded therein to provide a plurality of heating zones;

a second aluminum plate disposed beneath and supporting the first aluminum plate;

a third aluminum plate disposed beneath and supporting the second aluminum plate;

a non-metallic ring disposed atop the first aluminum plate;

a plurality of spacers having an upper portion disposed above a surface of the first aluminum plate, wherein the non-metallic ring and the plurality of spacers support the substrate above the first aluminum plate;

a purge ring disposed about a periphery of the first aluminum plate; and

a plurality of metal clips, wherein each of the plurality of metal clips comprise a first end coupled to the purge ring, a second end coupled to the first aluminum plate and a curved section coupling the first end to the second end, and wherein the plurality of metal clips electrically couple the purge ring to the first aluminum plate.

16. The substrate support of claim **15**, wherein the first end and second end of each of the plurality of metal clips comprise a through hole configured to allow the first end and second end to be coupled to the first aluminum plate and purge ring via one or more fasteners.

17. A process chamber, comprising:

a chamber body having an inner volume;

a substrate support disposed within the inner volume of the chamber body, the substrate support comprising:

a first aluminum plate for supporting a substrate, the first aluminum plate having a plurality of heating elements embedded therein to provide a plurality of heating zones;

a second aluminum plate disposed beneath and supporting the first aluminum plate;

a third aluminum plate disposed beneath and supporting the second aluminum plate;

a non-metallic ring disposed atop the first aluminum plate;

a plurality of spacers having an upper portion disposed above a surface of the first aluminum plate, wherein the non-metallic ring and the plurality of spacers support the substrate above the first aluminum plate;

a purge ring disposed about a periphery of the first aluminum plate; and

a plurality of metal strips, wherein each of the plurality of metal strips comprise a first end coupled to the purge ring, a second end coupled to the first aluminum plate and a curved section coupling the first end to the second end, and wherein the plurality of metal strips electrically couple the purge ring to the first aluminum plate.

18. The substrate support of claim **1**, wherein the non-metallic disk further comprises:

a through hole extending through the shaft and the non-metallic disk to prevent gas from being trapped between the non-metallic disk and the first aluminum plate.

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